



Method for Producing a Strong Bond between Two Layers of a Multilayer System, and Multilayer System

The invention relates to a method for producing a strong bond between two layers of a multilayer system, and to a multilayer system.

Multilayer systems are built up from at least two mutually adhering layers and serve, for example, as sensors for detecting substances such as for example gases. Those layers that detect the substance are referred to as functional layers.

A first severe disadvantage of such functional layers is that they do not adhere together with sufficiently high strength. For this reason, an additional intermediate layer yielding a greater adhesive action is necessary between two functional layers, which intermediate layer, however, brings about a second disadvantage in that the intermediate layer considerably diminishes the functionality of the functional layers.

In the case of a hydrogen sensor, for example, adequate measuring accuracy requires the cleanest possible boundary surface between the one functional layer made of palladium and the other functional layer made of silicon nitrite. Unfortunately, these two functional layers do not adhere together at all, so that between these two functional layers there must be an intermediate layer acting as a sort of cement, which intermediate layer adheres well both to the one and to the other functional layer. Suitable for the stated purpose in this example is nickel, which, however, greatly impairs or cancels entirely the functionality of a hydrogen sensor.

On the one hand, the functional layers should adhere strongly together, but on the other hand, their functionality must not be impaired.

It is not, however, as would be anticipated and is usually conventional, a goal of the invention to find the optimal compromise between adhesion and functionality, but rather to achieve a combination of both maximum adhesion and optimum functionality.

In terms of method, this goal is achieved with the features cited in Claim 1, in that anchors are embedded in at least one of the two layers.

In terms of device, this goal is achieved with the features cited in Claim 17, in that embedded in at least one of the two layers are anchors.

The invention provides for embedding anchors in at least one of the two poorly mutually adhering layers.

In an exemplary embodiment of the invention, an intermediate layer that adheres well but scarcely impairs the functionality is further applied to the one layer. The anchors provided according to the invention are partly embedded in the intermediate layer and the layer is applied to the intermediate layer. This practice yields good adhesion of the layers, because the intermediate layer adheres well to the bottom layer and because the intermediate layer and the top layer are mechanically strongly bonded by the anchors.

In a further exemplary embodiment, in a first step of the method, to a first layer there is applied, at least partially, a third layer acting as an intermediate layer, into which a plurality of contact holes are pierced. The contact holes can be pierced into the intermediate layer by, for example, an etching process or a photographic process. Next, the contact holes are filled with an adhesive compound. Excess adhesive compound issuing from the contact holes is removed, for example by etching away. In a further step of the method, the intermediate layer is stripped down to a specifiable minimum thickness, for example by an etching process or a photographic process. At the end of this process, anchors formed from the adhesive compound protrude from the intermediate layer. Now the second layer is applied to the intermediate layer. The anchors formed from the adhesive compound are now embedded both in the intermediate layer and in the second layer, so that the second layer is strongly bonded to the intermediate layer.

The contact holes and thus the anchors formed from the adhesive compound can be cylindrical in shape. Better anchoring is achieved, however, if the cross-sectional area of a contact hole and thus also of an anchor formed from the adhesive compound increases or

decreases from one end to the other end. The cross-sectional area preferably increases from the intermediate layer end to the second layer end,' so that the anchors have a conical or dovetail shape. This shaping yields an interlocking of the intermediate layer with the second layer.

In a further exemplary embodiment of the invention, there is a region free of the third layer, in which region the first layer and the second layer directly adjoin one another. The functionality is not impaired in the slightest in this region, while the anchors provided outside the free region yield good adhesion.

For the intermediate layer there is preferably a material that on the one hand enters into a strong physical or chemical bond with the one layer (i.e., the first layer or the second layer) but on the other hand impairs the functionality of the two layers only slightly. Along with mechanical anchoring, the selection of the plug material can additionally boost the adhesion of the second functional layer.

A dielectric is particularly suitable for the intermediate layer. The conical shape of the anchors is achieved for example with the aid of texturing methods that give well-defined weight to anisotropic and isotropic texturing.

The method according to the invention is suitable for example for fabricating sensors made up of a plurality of layers, but it is by no means confined to this application. Conductive layer bonds with strong adhesion can equally well be produced, such as for example bond pads in the case of semiconductors. Bond pads are most commonly fabricated from aluminum. In the case of bond pads made of aluminum, the temperature in subsequent manufacturing process steps must not exceed a value of 400 °C. This is particularly applicable in the case of methods for manufacturing semiconductor sensor chips. The present invention is not, however, restricted to the use of bond pads made from aluminum. Alternative materials are conceivable.

The invention will be described and explained in greater detail with reference to the drawings, in which:

Figure 1 depicts a first functional layer and a dielectric;

Figure 2 depicts the first functional layer and the dielectric with pierced contact holes;

Figure 3 depicts the first functional layer and the dielectric, whose contact holes have been filled with adhesive compound;

Figure 4 depicts the first functional layer and the dielectric with contact holes filled with adhesive compound, excess adhesive compound having been removed;

Figure 5 depicts the first functional layer, the dielectric stripped to a minimum thickness, with anchors formed from the adhesive compound;

Figure 6 depicts the first functional layer, the dielectric, a second functional layer, and anchors anchoring the dielectric and the second functional layer together;

Figure 7 depicts a multilayer system having a functional region with no dielectric; and

Figure 8 depicts a multilayer system having cylindrical anchors.

The steps of the method of one exemplary embodiment of the method according to the invention are now described with reference to Figures 1 to 6.

In the first step of the method, illustrated in Figure 1, a dielectric 1 is applied to a first functional layer 2.

In the second step of the method, as is depicted in Figure 2, contact holes 3, preferably in conical or dovetail shape, are pierced into dielectric 1. Contact holes 3 are pierced into dielectric 1 by, for example, an etching process or a photographic process.

In the third step of the method, illustrated in Figure 3, contact holes 3 are filled with an adhesive compound 4. Excess adhesive compound 5 issuing from contact holes 3 is removed by an etching process.

Figure 4 depicts functional layer 2, dielectric 1 adhering to it having contact holes 3 filled with adhesive compound 4, after excess adhesive compound 5 has been etched away.

In the next, fifth, step of the method, dielectric 1 is stripped down to a minimum thickness, for example by an etching process or a photographic process. Anchors 9 formed from adhesive compound 4 therefore have their upper part protruding from dielectric 1. Functional layer 2 and dielectric 1 adhering to it and having protruding anchors 9 are depicted in Figure 5.

Finally, in a sixth step of the method, the last step of the method, second functional layer 6 is applied to dielectric 1. Anchors 9 are now strongly embedded in dielectric 1 and second functional layer 6, and therefore bond second functional layer 6 strongly to dielectric 1. This complete arrangement according to the invention is shown in Figure 6.

A dielectric is especially suitable as an intermediate layer because it does not impair the functionality.

A further exemplary embodiment of the invention is shown in Figure 7. This exemplary embodiment differs from that depicted in Figure 6 in that there is a region 8 that is free of dielectric 1. First functional layer 2 and second functional layer 6 directly adjoin one another in this region 8. For this reason, the maximum functionality is achieved in region 8. Dielectric 1 and the anchors formed from adhesive compound 4, which are embedded both in dielectric 1 and in second functional layer 6, are arranged next to region 8.

The exemplary embodiment of the invention illustrated in Figure 7 shows clearly that maximum functionality is combined with maximum adhesion.

A further exemplary embodiment of the invention is depicted in Figure 8.

Applied to first functional layer 2 is dielectric 1, to which second functional layer 6 is adjacent. Anchors 9 formed from adhesive compound 4 are embedded both in dielectric 1 and in second functional layer 6. Anchors 9 are cylindrical in shape and therefore have the advantage that they can be produced more easily than the conically shaped anchors. The interlocking achieved with cylindrical anchors 9 is not, however, as strong as is effected with conically shaped anchors.

As already noted, the invention is suitable for multilayer sensors and conductive layer bonds in semiconductor technology, but is by no means restricted to these application fields.

In semiconductor technology, bond pads can be fabricated with the method according to the invention at process temperatures lying above 400 °C. The filling compound for forming the anchors is the element tungsten. The conductive layers, which correspond to the functional layers, are fabricated for example from a noble metal.

Values between 100 and 1000 nm have proven favorable as suitable dimensions for the diameter and spacing of the anchors. The layer thicknesses likewise lie between 100 and 1000 nm. The anchors protrude some 20 to 500 nm from the dielectric.

The method according to the invention is generally suitable for the production of multilayer systems whose layers do not adhere together well, but without the disadvantage of requiring intermediate layers that disadvantageously restrict the functionality of the multilayer system. The invention makes it possible to combine maximum functionality with maximum adhesive action.

List of Reference Characters

- 1 Dielectric
- 2 First functional layer
- 3 Contact hole
- 4 Adhesive compound
- 5 Excess adhesive compound
- 6 Second functional layer
- 7 Clean boundary layer between first functional layer and second functional layer
- 8 Functional region free of contact holes
- 9 Anchor